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Smoke Taint

I can smell smoke — now what?

While bushfires have already occurred in areas close to vineyards this season in some parts of Australia, ahead of the height of summer and the 2020 harvest, we put a series of questions on smoke taint to **Con Simos** and **Mark Krstic** of the Australian Wine Research Institute to help prepare our readers in the unfortunate event a fire threatens their region.

I can see or smell smoke near my vineyard. Are my grapes in danger of being tainted?

It's not easy to assess the risk of smoke taint risk based on the visual presence or smell of smoke in a vineyard. If you can smell or see smoke, it doesn't necessarily mean there's a high risk of smoke taint. While it is possible to measure the density of smoke particulate matter, the relationship between particulate matter and the risk of smoke taint has not been accurately quantified, although research is underway in this area. Low levels of smoke exposure (i.e. where visibility through smoke haze is >10-15km and/or %obscurtion/m is <0.05 $PM_{2.5}$) for a few days will generally not result in measurable or perceptible levels of smoke taint in grapes or wine (I. Porter, personal communication, 5 December 2019).

Which factors have an impact on the risk of smoke taint?

Every fire event is different in intensity, size, timing, fuel composition, topography and prevailing weather conditions. The likelihood of grapes becoming smoke tainted is affected by the smoke concentration, duration of exposure and its volatile phenol concentration and composition. The effects of smoke exposure also vary depending on stage of grapevine development when smoke exposure occurs.

At what stages of development are grapes most susceptible to smoke taint?

As grape berries develop and ripen, their susceptibility to smoke taint increases significantly. While there are bunches and fruit on grapevines, there is no risk-free period; however, the highest risk occurs between veraison and harvest (see Table 1, page 31).

Table 1. Stage of grapevine development and sensitivity of grapes to the uptake of free volatile phenols.

Grapevine growth stage (E-L stage)	Potential for smoke uptake
Shoots 10 cm in length (E-L 12)	Low
Flowering (E-L 19-26)	Low
Berries pea size (E-L 31)	Variable – low to medium
Beginning of bunch closure (E-L 32)	Variable – low to medium
Onset of veraison (E-L 34-35)	Variable – medium
Post-veraison leading up to harvest (E-L 36-38)	High

Are some grape varieties more sensitive to smoke taint than others?

All grapevine varieties can be affected by smoke taint. While some varieties may be more sensitive than others, the levels of smoke compounds in grapes will also depend on the timing of the smoke event in relation to grapevine phenology, and the duration and intensity of exposure. Processing techniques and style of vinification also have a big impact on the sensory impact of smoke compounds. For example, smoke characters in a fuller-bodied Shiraz wine may be less obvious than in a lighter-bodied Pinot Noir wine.

If I suspect my grapes might be smoke-tainted, what should I do?

The AWRI recommends a two-pronged approach to assessing the risk of smoke taint:

- analysis of potentially affected grapes for volatile phenols and non-volatile smoke taint precursors
- conducting a small-scale ferment that can be used for sensory assessment (protocol available on the AWRI website).

The timing of when to collect grape samples is critical, with the ideal time a couple of weeks prior to commercial harvest. This way the wines from any small-scale ferments will be available to assess in conjunction with the analytical data when making a commercial ▶



The criteria and grounds for the rejection or penalties of grapes from smoke by buyers needs to be clearly articulated in grape supply agreements.

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decision about whether or not to harvest the fruit. Sensitivity can vary between tasters, so wines should ideally be evaluated by an experienced sensory panel using randomised controls and repeats.

Sampling may be undertaken earlier (at say 7-9°Bé); however, the margin of error will be higher given the extra time grapes require to ripen on the vine and the additional smoke that they may be exposed to in the lead-up to commercial harvest date. Sensory assessment can also be difficult on wines made from early-harvested grapes due to the dominance of unripe green characters and higher acidity. This may mask any evidence of smoke taint, especially when just above background levels

How do I interpret smoke taint analysis results?

The same marker compounds that are present in smoke-tainted grapes are also typically present in clean, non-smoke-tainted grapes, albeit at reduced concentrations. It's important to ensure that the laboratory providing the analytical results can provide interpretation and ideally compare results against a database of natural background levels for the grape variety of interest. Results that are higher than background levels indicate that the grapes have been exposed to smoke. The higher the results are above the background levels, the greater the risk of smoke taint in wine made from those grapes.

Is there anything that can be done in the winery to lessen the impact or remove smoke taint?

Following smoke exposure of grapevines, a number of techniques can be employed in both the vineyard and winery

to minimise the sensory impact of undesirable smoke-derived aromas, flavours and compounds in wine. These techniques are summarised in Table 2 (adapted from Brodison 2013) and are more effective when used in combination rather than individually. However, it should be noted that while these techniques may help reduce the extraction and expression of smoke taint compounds, they are unlikely to eliminate the problem completely.

Should I expect my grapes will be rejected if they are deemed to be smoke-tainted?

Smoke-tainted fruit can be subject to penalties or rejection from grape buyers. The criteria and grounds for rejection/penalties need to be clearly articulated in the grape supply agreement (GSA). The GSA should list the minimum quality specifications for fruit, which may include clauses relating to exposure of grapes to smoke and/or the presence of smoke taint in the resultant wine. Ideally both producer and purchaser should agree on a process of establishing if the grapes are fit for purpose. This should include a combination of chemical and sensory analysis. Consideration should also be given to using an independent assessor. The AWRI can provide advice and it is also recommended that grape samples are collected, labelled and frozen, for future reference.

What research is being done in Australia on smoke taint?

The AWRI, Agriculture Victoria, La Trobe University and Wine Victoria are collaborating on a project funded by Wine Australia, the AWRI and the Australian Government Department of Agriculture as part of its Rural R&D for Profit program. The AWRI's primary role in the project is to evaluate a range of possible remedial management options (e.g. activated carbon products and enzymes) for dealing with smoke-affected grapes and wine. In addition, the project team is collaborating with Agriculture Victoria and La Trobe University to evaluate a range of possible monitoring, preventative and remedial management options and tools for dealing with the variable composition of atmospheric smoke and associated risk of smoke taint in wine. There are also smoke taint research projects underway at the University of Adelaide's Industrial Transformation Training Centre, with one investigating whether in-canopy misting can reduce the uptake of smoke in grapes and a second investigating the use of cyclodextrins for mitigating smoke taint in juice and wine.

Reference and further reading

AWRI smoke taint resources: https://www.awri.com.au/industry_support/winemaking_resources/smoke-taint/

Brodison, K. (2013) Bulletin 4847: effect of smoke in grape and wine production (Department of Agriculture and Food Western Australia: Perth, WA, Australia). Available from: <https://researchlibrary.agric.wa.gov.au/bulletins/203/>

Krstic, M.P.; Johnson, D.L. and Herderich, M.J. (2015) Review of smoke taint in wine: smoke-derived volatile phenols and their glycosidic metabolites in grapes and vines as biomarkers for smoke exposure and their role in the sensory perception of smoke taint. *Aust. J. Grape Wine Res.* 21 (S1):537-553.

For more information about smoke taint, contact the AWRI helpdesk on helpdesk@awri.com.au or 08 8 313 6600 (during business hours).

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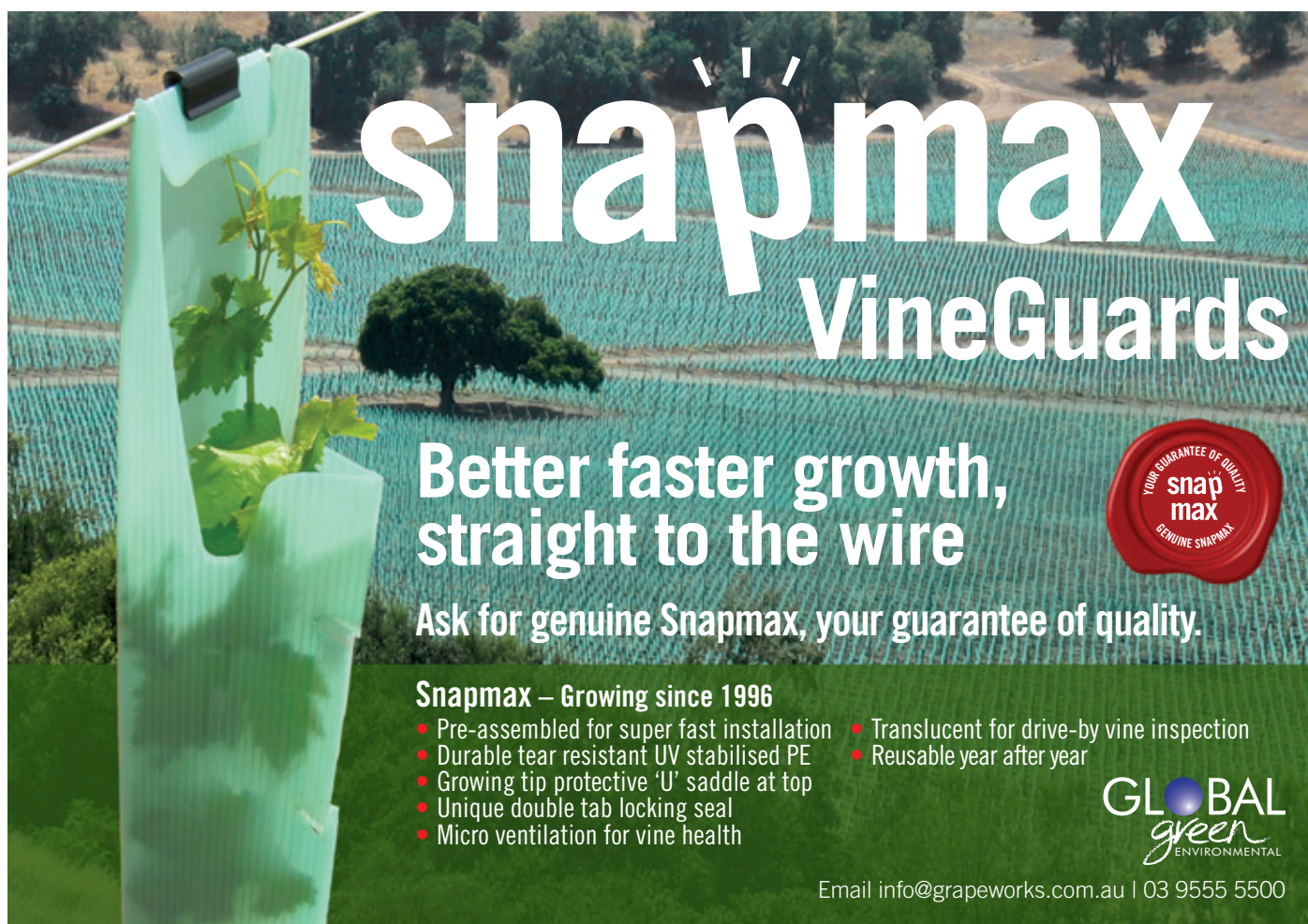
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Table 2. Summary of techniques to reduce smoke-related aromas, flavours and compounds during handling and processing of grapes and wine.

Management option	Technical explanation
Hand harvest fruit	Minimise breaking or rupturing of skins as long as possible.
Exclude leaf material	Leaf material can contribute smoke-related characteristics when in contact with fruit and juice.
Maintain integrity of harvested fruit	Avoid fruit maceration and skin contact with juice as this can lead to higher concentrations of smoke-related compounds.
Keep fruit cool	Fruit processed at 10°C had less extraction of smoke-related compounds than fruit processed at 25°C.
Whole bunch press	Whole bunch pressing has been shown to reduce extraction of smoke-derived compounds, particularly in white grapes.
Separate press fractions	Ferment free run juice and press fractions separately. There is less extraction of phenolic contaminants from smoke in the first 400 L/t fractions, especially when combined with fruit cooling.
Conduct trials with activated carbon	Fining with activated carbon (especially at high concentrations) is effective at removing smoke compounds from juice or wine, although it is unselective and will have a negative impact on overall aroma and flavour. Most other fining agents are ineffective.



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